Dengue Mosquito Control Assessment

13-15 April 2005

Dili, Timor Leste

Peter Whelan and William Pettit

Medical Entomology Branch
Department of Health and Community Services, Darwin
Northern Territory, Australia

For more information contact:

Department of Health and Community Services
Medical Entomology
PO Box 40596
Casuarina NT 0811

Telephone: 08 8922 8901
Fax: 08 8922 8820
Email: peter.whelan@nt.gov.au
1.0 Introduction

1.1 Background
A dengue outbreak has been underway in Timor Leste (East Timor) since the start of January 2005, with hundreds of cases and multiple deaths from dengue haemorrhagic fever/dengue shock syndrome reported by the Ministry of Health (MOH) Timor Leste.

The Northern Territory Department of Health and Community Services (DHCS) received a formal request from the Minister of Health Timor Leste on 05/04/2005 to provide advice to overcome the current outbreak and for a longer-term program to combat dengue disease in Timor Leste. This request was discussed with key DHCS officers and AusAID officers, who supported a visit by the director of Medical Entomology Branch to conduct an assessment of the current dengue control program and to provide advice on strengthening the dengue control program.

Two officers from the Medical Entomology Branch (MEB) of the Centre for Disease Control (CDC) of DHCS in Darwin travelled to Dili from 13/04/05 to 15/04/05 to conduct a brief survey of dengue control activities and have discussions with key personnel in the Ministry of Health Timor Leste. This draft report summarises the findings of the survey and makes recommendations on dengue vector control. This draft is to be submitted to AusAID, and via them to the MOH Timor Leste, for any comment and suggestions for corrections.

1.2 Terms of reference of assessment
The terms of reference was compiled by both AusAID and the MOH Timor Leste. They were to:
- Review the vector control strategy for dengue outbreak control.
- Review the house-to-house spraying activities.
- Review the community mobilization activities in Timor Leste.
- Provide recommendations to MOH for strengthening vector control strategies, house-to-house spraying and community mobilisation activities in Timor Leste.

1.3 Officers conducting survey
- Peter Whelan, Director and Senior Medical Entomologist, Medical Entomology Branch, CDC NT Department of Health and Community Services.

- William Pettit, Project Manager, NT Dengue Mosquito Eradication Project, Medical Entomology Branch NT DHCS.
1.4 Key personnel contacted in Dili

- Dr Rui Maria de Araujo, Minister of Health, MOH Dili
- Mr Johannes Don Bosco, Ministerial advisor MOH Dili
- Mr Mike Gallagher, NT Representative in Dili
- Ms Angelina Martins, Head of CDC Timor Leste
- Mr Joni Geger, CDC malaria officer MOH Dili
- Dr Yuwono Sidharta, WHO Dili
- Mr Helio Tavares, Senior program officer, Australian Agency for International Development

2.0 Methods

2.1 Larval mosquito sampling

Premises chosen for sampling for receptacles and larvae were opportunistic or at random, but broadly based on localities surveyed in the past by DHCS or the WHO entomologist. In each premise, all potential receptacles were inspected for water and as many larvae or pupae as possible in 5 minutes were sampled with the aid of a ladle and pipette. Samples were collected in to 70ml plastic containers with receptacle water. Any pupae were kept in original water until the last day. Any adults that emerged were killed by freezing them. Larval samples were preserved in a very small volume of 70% alcohol. All samples were taken to Darwin for laboratory confirmation.

2.2 Adult mosquito sampling

Adult mosquitoes were sampled opportunistically by collecting them in to a 70 ml plastic container as they were observed flying or resting during larval sampling or house inspections. They were killed by freezing and packaged in tissue for identification in Darwin.

3.0 Findings

3.1 Epidemiological aspects of the dengue outbreak.

There have been 933 cases of dengue and 37 deaths in Timor Leste in 2005 since the start of the outbreak on January 5 up to April 13. The cases occurred primarily in the three districts of Dili, Baucau, and Bobonaro. The majority of the cases in each district occurred in urban areas of the main town in each district.

Previous data up to 30 March indicated the majority of cases (76%) occurred in Dili district, with diagnosis by hospital reporting 77% of cases in Dili district being DHF/DSS and the remainder suspect dengue. Most of the cases have been dengue serotype 3 with some dengue serotype 1.

At the time of the current assessment there had been an apparent sharp decrease in total cases from the three main outbreak districts, from around 120 cases in the week ending April 5 to around 60 cases in the week ending 12 April. The drop occurred in all the three main outbreak districts of Dili, Bacau and Bobonaro. According CDC MOH Dili, this drop is likely to be a real decrease but may be partly due to a data collection lag.
3.2 Organisation of dengue control in Dili.

3.2.1 Vector control

Equipment
The MOH has about 7 operational backpack motorised mister machines, one ULV Leco adulticide aerosol fogger, and 2 or 3 smoke swing foggers. This was reported to be the equipment for the whole of Timor Leste. There is reported to be little scope for repair of the machines when they malfunction. The Leco ULV fogger had been donated to the MOH but had adaptations and repairs to make it operational, and lacked any mechanism for effective monitoring or adjusting flow rates of insecticides to deliver the recommended dose rates.

Operation of equipment
During the national clean up day on 14 April all machines were observed in operation in the Caicoli area near the MOH offices and surrounding residential areas.

The MOH conducts spraying and fogging with this equipment with the aid of volunteers or contracts to others. The staff operating the machines on national clean up day were very enthusiastic and conscientious, and were well supported by CDC MOH staff and the Minister of Health Timor Leste, who personally accompanied the operators and assisted in their briefing.

However the mister operators had very little personal protective gear apart from cloth facemasks. The operators of the misters did not appear to have sufficient training in the application measures specific for dengue mosquito control. The operators of the mist machines were entering houses to spray but were also spraying storm water drains and vegetation around and outside houses where there are unlikely to be any dengue mosquito larvae or adults. The mister operators were applying lambda cyhalothrin, a synthetic pyrethroid insecticide, as a space spray inside houses in a manner that would largely kill adult mosquitoes present at the time of application. However the label recommendation for use of this insecticide is as a residual treatment to surfaces rather than a space spray.

Likewise the swing fog operators appear to have little protective safety gear. The swing fog operators were fogging inside houses, which is optimal for dengue control, but they were also operating in drains and vegetated areas around houses. The insecticide being used in the foggers was lambda cyhalothrin. The best insecticides for this are those labelled for fogging such as the synthetic pyrethroid bioresmethrin or an organophosphate such as malathion.

The Leco aerosol machine was observed being used in streets. It is thought that this machine was dispensing malathion, an appropriate insecticide for delivery by this machine.

Insecticides
CDC staff informed us that there was a limitation to the continual use of the LECO and other equipment due to a shortage of insecticide and fuel to run the machines. The operators appeared to have little knowledge of the insecticides that they were using.

Private mosquito control
Mr Mike Gallagher NT representative in Dili reported that some of the hotels employed a company to treat the premises for mosquitoes. He did not know the particulars except that the clients were asked to vacate the premises for 4 hours while the fogging was carried out. He
reported that there were very few mosquitoes in the grounds of his hotel after the fogging operations.

Other vector control operations.
It was stated by CDC staff that larval control had been carried out, but we did not have the opportunity to observe any of these operations and none appeared to be carried out during our brief survey.

Public education
The principal method of public education observed during our visit was the CDC program of using a vehicle with loud speakers going around the streets attracting people to locations for education and putting out the messages to clean up receptacles and implement personal protection from mosquitoes. CDC staff advised that they were active in many districts at the village level with CDC staff conducting public education through various community groups and organisations. The principal messages were to alert people to the danger of dengue mosquitoes, and basic methods of control including tipping out water in receptacles, and using nets and repellents in houses.

During the national clean up day in Dili to prevent dengue, we observed many people in both groups and as individuals cleaning drains and putting out rubbish for collection. There were a number of trucks collecting rubbish and although this included rubbish and silt from drains, it also included used drums and tyres, which are principal breeding sites for *Ae aegypti*. The MOH had done a great job in getting out the message and motivating people to action.

There are 4 local papers in Dili. The Timor sun is aimed at expatriates. In the current issue there was an article about dengue cases and deaths but no information on personal measures that people could take. The other three, Suria Timor Laurisi, Diario, and Timor Post are aimed at local residents. One of the local papers (Diario) published 14 April during our visit, had a front page image of a mosquito and a message alerting people to the national clean up day for dengue control and inside had a large education sheet on dengue control, with diagrams on breeding sites and actions to destroy mosquito breeding and self-protection measures. This public education measure was excellent. However at US$0.50, many people may not have enough money to buy these papers.

There is also a local radio station and a local TV station, although it is unknown if any public education is covered in these media types.

3.2.2 Use of personal mosquito protective measures
While surveying near residences and in streets we saw evidence of used sachets of insect repellent Autan brand (Johnson company) 12.5% DEET in 10gram packs. These were reported to cost US10c each and may be within the budget range of many households. A CDC staff member reported that these were widely used.

There was little evidence of the use of treated bed nets but our inspection was very limited. A CDC staff member reported that there was little use of bed nets because they were too hot, became dusty, or were used for other purposes rather than sleeping under. There was also a problem with the reimpregnating of nets and the replacement of damaged nets.
A number of shops in Dili had good supplies of aerosol cans of insecticides and repellents for sale. The insecticides included both surface spray such as the Baygon brand with active ingredients propoxur and transfluthrin, and space spray such as the Baygon brand with active ingredients cyfluthrin and transfluthrin. However the surface spray was about US$5 each and would not be within the budget of many people in Dili.

### 3.3 Entomological information

There has been a relatively brief but thorough entomological survey 11/02/05 – 26/02/05 by Dr Yoshio Tsuda, National Institute of Infectious Disease, Tokyo Japan. Key findings of his survey were:

- Key containers in surveyed areas were plastic bottles and drums. Used tyres were also important breeding sites.
- The house index of 64 and Breteau index of 124 was similar to that observed by in 1999 (Whelan and Hapgood 2001), and places Dili in the high-risk category for dengue transmission.
- *Aedes aegypti* was the major potential vector species in the 3 areas of Dili surveyed
- The average number of resting females and male *Ae. aegypti* per house was 1.8 and 3.4 respectively.
- Flowerpots in cemeteries showed a high rate of infestation rate of 46.25 with *Aedes aegypti* and *Aedes albopictus*.

### 3.4 Results of entomology survey 13 –15 April 2005

#### 3.4.1 Areas inspected

- Foreshore opposite Dili hotel near floating hotel, Avenida Dos Direitos Humanos, Dili.
- Residence of MOH staff, Lahane, in foothills, Dili.
- Bebonuk area near church, near coast, west end of Dili.
- Moris Feun B residential area near Timor lodge, western side of Dili.
- Desa Hera, coastal village and river valley village, east of Dili.
- Hotel Audian, Audian area, central residential houses, Rua Qinze de Octobro, Dili.
- Caicoli area residences near MOH, central residential area, Rua de Caicoli, Dili.
- Dili National Hospital, East side of Dili, Rua Cicada Urana do Castelo, Dili.
- Santa Cruz cemetery, central residential eastern side. Rua Santa Cruz, Dili.

Photographs of areas inspected and mosquito breeding sites are at Attachment I.

#### 3.4.2 Mosquito breeding sites

**Dengue vectors**

Our very brief spot checks indicated relatively widespread and numerous *Aedes aegypti* and *Aedes albopictus* breeding occurring in Dili. There were numerous breeding sites in residential areas including rain filled receptacles and purpose filled receptacles used to store water. This supports the recent findings of Tsuda above in section 3.3. The results of the current survey are in Tables 1 and 2.

The Breteau index gives an indication of dengue receptivity but other survey methods and indexes are available to evaluate risks of dengue outbreaks. These include pupae and larval
numbers in receptacles and adult mosquito indexes. These figures can give indications of productivity of various receptacles, and the numbers of adult numbers that has a direct bearing on disease risk. Our survey did not have time to conduct these in depth surveys but the larval productivity from the drums and tyres, and the numbers of adults trying to bite in the cemetery outlined in the results, give a good indication that Dili has sufficient vector numbers for dengue outbreaks.

**Malaria vectors**
Our brief survey did not find evidence of any appreciable malaria vector breeding in most residential areas of Dili. The former brackish water areas on the coast near the mouth of the Comoro River were dry or nearly dry during our visit. However one *Anopheles subpictus* larva was found in a shallow saline pool in this area.

The principal areas of potential malaria vector breeding include Caicoli, the rice areas to the west of Dili, and Comoro and Santana rivers. The areas of malaria risk would be within 500m to 1km of any appreciable breeding in these areas. More information can be found in the two reference reports.

Outside Dili there were considerable areas of potential malaria vector mosquito breeding sites, in particular the Desa Hera valley and near coastal areas of this valley. The upper reaches of this valley were within a short distance and less that 1 km from the outskirts of Dili.

**Filariasis vectors**
*Culex quinquefasciatus* was found breeding in very high numbers in storm water drains in a number of areas and septic tanks in the hospital. It is likely that there are very high numbers of these mosquitoes breeding wherever storm drains are blocked or stagnant. However wherever there was appreciable flow in drains and where there was no blockage for fish access from downstream, small fish predation in storm drains was extremely efficient and no larvae were present wherever the fish were present. The fish appeared to be the small Indian tooth carp or pancha species but it is possible two species were present. Any vector control in drains should be carried out only with non-pyrethroid insecticides and only with recommended insecticides at label rates in order to prevent fish kills. Any fish kills have the potential to dramatically increase *Culex quinquefasciatus* pest problems in that locality.

*Culex quinquefasciatus* is a common pest species and would be causing a major pest problem at night in most areas of Dili. The presence of high numbers in the septic tanks at the hospital is a particular concern and could be controlled by sealing the tanks or applying insecticides to the tank walls and in the liquid in the tank. More information on this species in Dili can be found in the two reference reports.

*Mansonia uniformis* is also a potential vector of filariasis. More information can be found in the two reference reports.

**Japanese encephalitis vectors**
*Culex tritaeniorhynchus* larvae were found in a flooded grass are near the MOH offices. This species is regarded as an efficient vector of JE. However this particular area was relatively small. In addition many pigs, which are the principal reservoirs and amplifying agents of JE, were observed in Dili residential areas and in village areas in Desa Hera. More information can be found in the two reference reports.
3.4.3 Adult mosquito activity

While conducting the survey a number of adult mosquitoes were observed flying or harbouring. Many *Culex quinquefasciatus* adults were observed harbouring in dark corners in and near houses, particularly in damp shaded areas. Some *Ae. albopictus* were observed in areas close to houses and attempted to land on our clothing. The most adult *Ae. albopictus* were observed in Santa Cruz cemetery trying to land on our clothing.

4.0 Discussion

4.1 Current dengue outbreak

The number of cases of suspected dengue is very small relative to the number of cases of DHF/DSS. In addition there has been no sharp peak in the numbers of cases. This suggests many more cases of classic dengue have occurred and could still be occurring.

In the current outbreak there is a lack of distinction between suspected cases and confirmed cases. This is presumably due to the lack of laboratory testing and a reliance on clinical symptoms. This reliance on clinical symptoms for epidemiological records of cases is justifiable in the present circumstances in Timor Leste and is sufficient at present until the current epidemic is much reduced. However there should be a review of the recording of dengue cases to examine how timely and accurately the recording of both suspected cases and confirmed cases could be carried out. This is so that accurate indications are available to warn of a future epidemic in following years, and to be able to direct vector control resources rapidly to areas where recent cases are occurring.

There is sufficient *Ae. aegypti* in Dili to continue the current epidemic, and the continuation of the current outbreak will now depend on the number of infected people supplying virus to dengue mosquitoes and the number of non-immune people available. If *Ae. albopictus* is acting as a vector it is probably contributing considerably less than *Ae. aegypti*, but is possibly a large factor in the Santa Cruz area near the cemetery.

The most urgent task is to reduce the number of adult *Ae. aegypti* mosquitoes, which are possibly infected with dengue virus. It is possible that the number of cases will decrease soon as the dry season begins. However there are still ample mosquito vectors present from stored water sources. The outbreak could still be maintained for at least a month but at reduced levels.

A number of immediate recommendations are made to try to reduce the current epidemic as soon as possible. If these recommendations cannot be implemented within one month, it is likely that the effort could not be justified as the current epidemic may be at low levels or over. The resources and planning should then be directed to the short and medium term issues to prepare for the next wet season.

4.2 Current vector control

It is clear that the current fogging and misting operations conducted by the MOH and private contractors are having an effect in reducing adult dengue mosquito numbers. This is probable by the application of insecticide measures observed by us on the clean up day and by reports of reduced numbers of mosquitoes from a client in one of the hotels. It is also probable from the number of cases, which are not showing a sharp peak, indicating that some control mechanism is present. However some of this fogging and misting is being applied to fences...
and in vegetation around houses and in drains, and hence is not being optimised for the main
target areas of inside houses where most of the *Ae. aegypti* will be present.

The current fogging and misting operations with the back pack misters or swing fogs, when
applied inside houses, are acting effectively as space sprays and killing adult mosquitoes
inside the houses. However they are not likely to leave any residual insecticide on the inside
of houses to maintain longer term control of adults.

The current operations are also not being the optimal effect of killing larvae or treating
breeding receptacles, so that the overall adult vector population may not be reduced for any
length of time in any one location.

The current clean up Dili campaign has achieved much in public education and motivation.
There were obvious receptacles put out for collection, which is achieving some source
reduction of breeding places. However there was considerable drain cleaning and vegetation
cutting. Much of the cleaning of drains has little impact on dengue transmission although has
a great deal of value in reducing *Culex* mosquitoes, particularly *Culex quinquefasciatus*, the
main pest mosquito in houses at night in Dili.

4.3 Organisation of vector survey and control operations
There was a report that WHO was working with the MOH on a short term and long-term
strategy for dengue control. We had no opportunity to discuss this report with any WHO
officers during the brief period of the survey visit in Dili. The presence of a strategy or
progress on this strategy should be clarified as soon as possible with WHO officers and the
MOH in Dili.

One of the first priorities should be to set up a dedicated unit within the MOH to carry out
dengue mosquito surveys and vector control operations.

Organisation of a dedicated vector survey and control unit can make a large impact on dengue
transmission by reducing adult numbers of dengue mosquitoes. This unit will need to conduct
a premise-by-premise search and treatment operation by experienced and trained vector
survey and control staff. The staff involved in vector survey operations should be specialised
and appropriately trained but also be involved in control operations with others who have a
primary duty as insecticide application officers. The personnel must be recruited locally so
that they are familiar with local people and locations. The unit should be within the Ministry
of Health and be able to employ short-term operators with a core of trained fulltime staff.

The application of space sprays and fogging to kill adult mosquitoes in houses and the
application of residual spray insecticide in houses and the treatment of key receptacles in and
around premises by a vector control unit should be a high priority. Residents of Dili can not
be expected to locate and treat all dengue mosquito breeding places in and around their
residences, although they can play a considerable part in this if they are given key information
outlining measures they can take to assist source reduction.

4.4 Suggestions for improved vector control in the immediate term.
While the present personnel and insecticides are available, and there is evidence that the
current outbreak is continuing, the current operations should proceed, with some
modifications, until further equipment, insecticides and personnel are available.
The misting operations by the back pack machines should be modified to apply the lambda cyhalothrin to the dark walls and objects inside of houses and close outbuildings such as laundry or washing areas, so that a residual film of insecticide is left on the walls. This could be achieved by directing the mist from the machine at a close distance from the walls. However before these operations are modified, all operators need to be supplied with the correct safety equipment including safety masks with filters to protect them from insecticides in confined areas.

Fogging with swing fog machines should continue but the main thrust of operations should be in areas of known dengue transmission and the operators should direct most of the effort to inside residences to kill adult mosquitoes. The area of operations should be in a 100m radius of residences where dengue cases have occurred in the recent week. Swing fog machines usually dispense a Malathion or pyrethroid and diesel mix as a smoke. They are very effective at killing mosquitoes inside buildings but may not leave much insecticide on surfaces and hence any control by them is likely to be short term, probably only for a matter of days.

Fogging with the Leco HD truck mounted machine is fine in relatively open areas with little vegetation and if the aerosol/mist can be applied to drift into the desired target areas. This machine has large limitation due to wind speed and direction often not being optimal. In addition the aerosol produced by this machine does not penetrate buildings very readily and tends to go around or over objects. If this machine is to be used in urban areas there should be publicity to obtain public cooperation to open windows and doors to maximise the effect of killing adult mosquitoes. It is capable of covering large areas rapidly with the correct application rates and even if only partially effective it can treat large areas quickly. The machine should be calibrated to apply the correct flow rates, and the vehicle speed necessary to deliver these rates should be calculated and used. With the limitation of this machine in mind, it is suggested that any operations of this machine in urban areas should be followed up with indoor misting and the application of residual insecticides to walls and receptacles indoors or to appropriate buildings in close association with residences.

There should be a purchase and use of hand held pressure sprayers to deliver residual insecticide to inside houses and breeding receptacles. Santa Cruz and other cemeteries should be specifically targeted as very significant sources of vector mosquitoes and treated with appropriate insecticides as soon as possible. This equipment is labour intensive but is very effective in applying a residual insecticide inside houses and such applications would be able to keep killing adult mosquitoes as they rest on walls and objects for up to 6 weeks and possibly longer.

The public education releases seen to date are excellent. There should be additional funds to enhance this education so that posters can be made and put up in public places, and more advertisements can be prepared and inserted in local newspapers. Any aspects of community communication that can be strengthened should be examined.

If the outbreak continues for more than a few weeks, then resources should be moved from adult control to more long term control such as applying residual insecticide to walls and receptacles.

4.5 Suggestions for improved vector control in the short and medium and long term. There should be a planned integrated vector control program with appropriately trained and equipped staff, so that most measures are in place before the next wet season. Detailed
recommendations for short, medium and long-term objectives are detailed in section 5.0. A detailed budget and funding will need to be available for these measures.

4.6 This report
This report has been prepared in haste in order for it to be submitted to AusAID as soon as possible for consideration and to seek feedback from the MOH Timor Leste. The immediate measures recommended are made in presumption that there is epidemiological information that the current outbreak is continuing and the immediate measures are worthwhile in the next month. Any errors in reported comments from others or errors of facts are apologised for in advance. Comments are welcome so that corrections can be made or aspects can be clarified.

5.0 Recommendations

5.1 Immediate
Tasks, within one month

Reduce the number of infected adult female dengue mosquitoes by indoor space spraying and indoor residual applications of insecticide, and increase self-protection measures by population in transmission areas.

Measures necessary include:
- Draw up a plan for immediate and short term dengue vector control activities in Dili.
- Organise funds for increase in staff numbers in the CDC for specific vector control activities.
- Strengthen all MOH activities to enhance and communicate with the community on community needs and participation in dengue control.
- Enhance and strengthen dengue disease surveillance and establish a clear link with epidemiological information and vector control activities.
- Supply personal protective gear including overalls and respirators for all spray operators.
- Supply instructions and education on basics of insecticides and recommendations for use of different insecticides. This should include confining space spraying and residual spraying to indoor locations or immediate peri indoor locations i.e. shaded front or rear of premises.
- Provide funds to fix all existing vector control equipment.
- Purchase and supply of insecticide for space spray by swing foggers or back pack misters to kill adults in houses eg bioresemethrin
- Purchase and supply of Rega pressure sprayers and insecticides to apply a residual insecticide such as bifenethrin or lambda cyhalothrin to inside surfaces in houses and to receptacles in and near houses.
- Organise education articles in local papers and local radio ads on key breeding containers and receptacles and recommend action that can be taken by residents with minimum cost to themselves.
- Upgrade and enhance the cleanup of receptacles with a specific target of drums, tyres and old plastic receptacles. No collection of vegetation or soil.
- Supply personal repellents (DEET based) in sachets to public until current outbreak is reduced
- Distribution of sachets of Abate to residents for larval control in buc mandis and water storage drums.
- Target treatment of vases in cemeteries with abate or methoprene pellets and apply bifenthrin spray to all vases.
- Conduct adult aerosol space spraying with misters or swing foggers inside all houses in Dili where recent cases of dengue occurred until the current outbreak ceases.
- Conduct indoor space spraying and indoor residual spraying in all houses in Dili for a 200m radius in localities where dengue cases are still occurring.

**Organisation to carry out immediate tasks**

It is proposed to send Peter Whelan, senior medical entomologist NT DHCS to Dili for the one month to work with the MOH to set up the initial organisation of vector survey and control and initiate revised vector control and public education measures, primarily for Dili. He is an experienced medical entomologist of over 30 years experience, with a national reputation and specific expertise in the survey and control of dengue vectors. He has organised and implemented a dengue mosquito eradication program in a town in the NT with the support of the Commonwealth of Australia. He would be supported technically by MEB staff, which would rotate at weekly intervals to Dili. These staff would assist in training of local staff in surveys and the application of insecticides.

The operational program would need a budget of approximately A$200K to fund the personnel aspects of the assistance, purchase all operational equipment and insecticides, hire local staff, etc. This arrangement would need to be funded by AusAID or another aid agency.

**5.2 Short term, within 6 months**

Implementation of measures to reduce the breeding dengue mosquitoes, including receptacle reduction, removal of water in receptacles, and the application of residual insecticide to receptacles before the next wet season.

Measures necessary include:
- Engage a specialist medical entomologist to plan a dengue control strategy for Timor Leste within a national vector control strategy to include malaria, Japanese encephalitis and filariasis. The consultant should also assist the MOH in the establishment and training of a vector survey and control unit.
- Organise and purchase all insecticides and the consumables necessary for the next year program.
- Purchase additional vector control equipment and implement a measure to ensure all equipment is fully operational.
- Set up and fund a specialised vector survey and control unit within the MOH. This should include a medical entomologist or specialist in vector ecology and control.
- Set up basic training courses for instruction of key operational staff including CDC staff and vector survey and vector control staff.
- Purchase and instruct staff in the use of insect sampling and data recording techniques. This includes ladles, vials, supply of 70% alcohol, mechanical aspirators, and adult collection techniques.
Conduct entomological surveys and collect data in the two major towns of Dili and Baucau.

Supply of both a stereo and a compound microscope for identification of larvae in at least Dili and Bacau.

Expand the public education program. Prepare detailed education articles for local papers and local radio on key breeding containers and receptacles, and recommend action that can be taken by residents with minimum cost to themselves.

Prepare public education posters on dengue mosquito biology and control, and personal protection measures for installation in major public places in all major towns in the Tetum language.

Organise funding to purchase and distribute cheap water holding containers (20-50 litres) with lids in all areas of Dili and Baucau without water reticulation. Education on proper use of water storage receptacles to exclude mosquitoes.

Conduct residual spraying of inside of all houses in Dili and Bacau and then smaller villages if sufficient resources.

Conduct residual spraying of all receptacles or treat actual breeding sites with alternative insecticides in residential areas by premise-by-premise inspection and treatment.

Organisation to carry out short term tasks

AusAID should advertise for a specialist entomologist consultant to carry out the tasks as outlined. The consultant could be assisted in Dry season activities by regular visits by DHCS MEB staff to assist with training for survey, identification and control operations with reimbursement by AusAID. The planning and operations should be in place ready for the start of the next wet season.

5.3 Medium term within 12 months

Establish on going programs of organised adult vector control and source reduction to reduce and maintain low levels of the overall population of dengue mosquitoes. Implement the organisation to be able to respond appropriately to outbreaks of dengue.

Measures necessary include:

- Establish, fund and equip a permanent and trained staff in vector control in at least Dili and Baucau and expand to other major towns if sufficient resources are available.
- Activities of spray teams to be tied closely and timely to the weekly epidemiological data of new cases of suspected or confirmed dengue.
- Used tyre collection and disposal to land fill or hole to remove water.
- Education on type of vases or maintenance treatment of vases to preclude mosquito breeding.
- Funding to prepare specific mosquito borne disease advertisements for TV, radio and print media and funding to run these just before and during the next wet season.
- Training of local Timor Leste staff to carry out most tasks for routine survey and control operations.
- Conduct adult aerosol space spraying with misters or swing foggers inside all houses in main towns of Dili and Baucau and Bobonaro where recent cases of dengue occur.
- Conduct indoor space spraying and indoor residual spraying in all houses in Dili and Baucau before the start of the next wet season.
Organisation to carry out medium term tasks

Continuation of specialist entomological consultant to implement all aspects of 12-month plan.
Continuation of assistance by DHCS staff with reimbursement by AusAID.

5.4 Long term after one to two years and continuing on ongoing basis

Maintain and improve all aspects of an integrated vector control program, including public education, training of vector survey and control staff, and the epidemiological organisation to quickly and accurately record cases of dengue

- Maintain and fund a permanent and trained vector control unit in at least Dili and Bacau and expand to other major towns as soon as possible.
- Attach priority to reinstalling piped a water supply to residential areas of two major towns to reduce need to store water.
- Establish standards for septic tanks and water tanks and initiate inspections to ensure they are mosquito proof.
- Conduct entomological surveys and collect data in all major towns of Timor Leste and expand to smaller towns and areas of reported dengue activity.
- Annual survey and residual spray program before each dengue season.
- Storm water drain repair and reconstruction to rectify mosquito breeding of other species of mosquito.
- Annual public education programs to reduce breeding sites of dengue mosquitoes

6.0 References


7.0 Acknowledgments

We would like to particularly acknowledge the great direction, information and assistance given by Ms Angelina Martins and Mr Joni Geger of CDC MOH Timor Leste during this assessment in Dili. We would also like to thank Dr Rui Maria de Araujo for making time and the opportunity to accompany him on his personal assessment of clean up Dili day. Dr Yuwono Sidharta for assistance with WHO documents, and travel and accommodation advice.
We would also like to thank Helio Tavares, senior programs officer, AusAID, for contacts and advice.
MEB staff assisted with the identification of specimens carried out by Mr Mathew Shortus exotic vector control officer, and Mrs Tamara Pearce with very able assistance with the preparation of the budget and various administration tasks.
This assessment has been fully supported by NT DHCS officials including Dr Vicki Krause Director, Centre for Disease Control, Dr David Ashbridge Assistant Secretary Health
Services, CEO of DHCS Mr Robert Griew, and the Minister of Health and Community Services Dr Peter Toyne.
Table 1  BITING / RESTING RESULTS DILI EAST TIMOR, 14-15 APRIL 2005

<table>
<thead>
<tr>
<th>Date collected</th>
<th>Location</th>
<th>Suburb</th>
<th>Indoors / Outdoors</th>
<th>Biting / Resting</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/04/05</td>
<td>Site 1 - Church.</td>
<td>Bebonuk</td>
<td>Outdoors</td>
<td>Resting</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Site 2 - Lehane (near pigs)</td>
<td>Lehane</td>
<td>Outdoors</td>
<td>Resting</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Site 3 - Next to Timor Lodge</td>
<td>Moris Feun B</td>
<td>Outdoors</td>
<td>Resting</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Site 4 - Santa Cruz Cemetery</td>
<td>Santa Cruz</td>
<td>Outdoors</td>
<td>Biting / resting</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>
## Table 2

### LARVAL MOSQUITO SURVEY DILI EAST TIMOR, 14 - 15 APRIL 2005

<table>
<thead>
<tr>
<th>Record no</th>
<th>Date Collected</th>
<th>Suburb Name</th>
<th>Address</th>
<th>Habitat Description</th>
<th>Species</th>
<th>1st instar</th>
<th>2nd instar</th>
<th>3rd instar</th>
<th>4th instar</th>
<th>Pupae</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB00844</td>
<td>14/04/2005</td>
<td>Santa Cruz</td>
<td>Site 1: Santa Cruz - cemetery</td>
<td>Sunken engraved square on top of stone grave.</td>
<td>Ae. aegypti</td>
<td>9</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site 2: Santa Cruz - cemetery</td>
<td>Rain filled vase on grave. Situated in shade.</td>
<td>Ae. aegypti</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site 3: Santa Cruz - cemetery</td>
<td>Rain filled vase on grave. Vegetation in discoloured water.</td>
<td>Ae. albopictus</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>CB00845</td>
<td>14/04/2005</td>
<td>Bebonuk</td>
<td>Site 4: Bebonuk - residential</td>
<td>1000 litre water tank, nearly empty.</td>
<td>Ae. aegypti</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>CB00848</td>
<td>14/04/2005</td>
<td>Dili city</td>
<td>Site 5: Opposite Dili Hotel</td>
<td>Wooden dugout canoe.</td>
<td>Cx. (Lut) halifaxii</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site 6: Opposite Dili Hotel</td>
<td>Metal pipe in scrap metal pile.</td>
<td>Ae. aegypti</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site 7: Opposite Dili Hotel</td>
<td>Brake drum in scrap metal pile.</td>
<td>Ae. albopictus</td>
<td>26</td>
<td>0</td>
<td>4</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>CB00849</td>
<td>14/04/2005</td>
<td>Bebonuk</td>
<td>Site 8: Bebonuk</td>
<td>Saline pools - beachside near mouth of Comoro River.</td>
<td>Cx. (Cux) vishnui</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cx. (Lut) halifaxii</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oc. (Och) vigilax</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>An. (Cel) subpictus</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CB00846</td>
<td>14/04/2005</td>
<td>Lahane</td>
<td>Site 9: CDC Officers residence</td>
<td>Tyre (motorcycle).</td>
<td>Ae. aegypti</td>
<td>29</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ae. albopictus</td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tp. (Pol) punctolateralis</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>CB00850</td>
<td>14/04/2005</td>
<td>Lahane</td>
<td>Site 10: CDC Officers residence</td>
<td>20 litre unsealed drum.</td>
<td>Ae. aegypti</td>
<td>123</td>
<td>79</td>
<td>7</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ae. albopictus</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>CB00853</td>
<td>14/04/2005</td>
<td>Moris Feun B</td>
<td>Site 11: Moris Feun B - residential</td>
<td>Bac mandi inside house.</td>
<td>Ae. aegypti</td>
<td>123</td>
<td>79</td>
<td>7</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ae. albopictus</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>CB00854</td>
<td>14/04/2005</td>
<td>Moris Feun B</td>
<td>Site 12: Next to Timor Lodge</td>
<td>Aluminium bowl.</td>
<td>Ae. aegypti</td>
<td>123</td>
<td>79</td>
<td>7</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ae. albopictus</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>CB00852</td>
<td>15/04/2005</td>
<td>Caicoli</td>
<td>Site 13: Central residential area</td>
<td>Grassy ground pool.</td>
<td>Cx. (Cux) tritaeniorhynchus</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cx. (Cux) quinquefasciatus</td>
<td>18</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drain holding water next to building.</td>
<td>23</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unsealed septic tank.</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shaded, grassy, freshwater ground pool.</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CB00851</td>
<td>15/04/2005</td>
<td>Dili city</td>
<td>Site 14: Dili National Hospital</td>
<td>Cut-off drain.</td>
<td>Cx. (Cux) quinquefasciatus</td>
<td>18</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tp. (Pol) punctolateralis</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shaded, grassy, freshwater ground pool.</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Grand Total**

|          | 380 | 106 | 21 | 61 | 181 | 11 |